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SMELL THE DOMINANT SENSE IN *DIABROTICA 12-PUNCTATA* AND *LIMAX MAXIMUS*.

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The extraordinary acuteness of the sense of smell exhibited in many of the lower animals has been known so long that it is unnecessary to more than mention it. I recall numerous examples illustrating the extreme development of this sense as recorded in the literature, among the insects, the *Lepidoptera** especially, and in the *Mollusca*† in both marine and terrestrial species.

The following instances observed by me are not without interest, and worthy of notice, being of practical value.

The first occurred half a century ago, being one of various experiments of an agricultural character on my homestead acres, known as Claybrook in Norfolk County, Mass., in 1857–8.

In the spring of these years cucumber seed was planted on about half an acre, divided into two flats of nearly equal area by a roadway about ten feet wide. When the seed in the easterly plot had germinated and the first leaves began to peep above the ground the plants were protected by wooden frames twelve inches by twelve inches in size made of ordinary inch-thick boards. These frames were simply a box without a bottom, six inches in depth, the top covered with common mosquito netting. On the opposite or westerly side of the driveway, early peas were planted in rows, the rows being four feet apart. When the peas were four or five inches high the cucumber seed was planted in the space between every second

* Science Gossip, London, Hardwicke; various volumes.

† The Cambridge Natural History, Vol. III, *Mollusca*, pp. 192–196 and elsewhere.

row, so as to make the cucumber stands, or hills, eight feet apart each way, or 680 to the acre.

By the time the peas had made a growth of from eight to ten inches and the cucumber plants were showing their second or third pair of leaves, the spotted cucumber beetle *Diabrotica 12-punctata* made its appearance and commenced foraging. On the plot protected by frames, the beetles, to use a common expression, soon "struck the lead," and in many instances having worked their way under the edges of the frames, attacked the plants, doing considerable harm.

On the other plot the beetles were rarely seen, though as before stated, these plots were only ten feet apart. Here the pea odor not only neutralized the odor of the cucumber vines, but practically overwhelmed it. In volume of foliage, that of the pea vines or bushes compared with the leafage of the cucumber plants, was more than a thousand to one. The cucumber vines among the peas were not concealed from sight while those under the frames were materially obscured by the mosquito netting. It is during the early period of growth that the beetle is often exceedingly destructive. After the vines have become vigorously established the crisis as a general experience has passed, and the plants having attained a size so that their growth is restricted by the frames the latter have to be removed. The plants raised under frames may not be quite so hardy as those otherwise grown, but whether raised among the peas or under frames, in both cases considerable protection is given by these devices against unseasonable cold blasts such as not infrequently occur in backward or late springs.

Many years afterward when in Shawnee on the Delaware River in Pennsylvania, I noticed in a small vegetable garden that the owner protected his cucumber plants against the spotted beetle by dousing them with cow-manure diluted with water to the consistency of gruel or thin soup; this required repeating, as an ordinary rain storm would wash it off. It will be noticed that the odor of the manure overcame that of the cucumber vines, and is in the same line as the pea-cucumber experiment.

This method however is only practicable on a small scale. Where large areas of many acres are devoted to the cultivation of cucumbers, both the frame and Shawnee methods are unsatis-

factory. The latter because of the time and labor required, the frames because of the first cost and subsequent expense for repairs and the cartage to and from the field and storage when not in use, while the cultivation among peas has no limitation and two crops are produced on the same land to the pecuniary advantage of the grower. Aside from the value of the peas whether picked green or dried, the haul-in is excellent food for cattle and sheep; nothing is wasted, lost or without value.

In these latter days spraying with some insecticide is often resorted to. This is objectionable because of its poisonous character; it requires considerable labor and involves expense, while the pea-vine plan is scientific, natural and has no limitations; it is comparatively inexpensive, and ordinarily one season with another fairly profitable, not only in dollars and cents, but also from the point of view that like all leguminous crops, peas extract nitrogen from the atmosphere, and the soil from which a crop of peas has been harvested is richer in this fertilizing element than before the peas were sowed upon it.

It is not unreasonable to assume that other pestiferous insects may be thwarted, by careful experiment in the same line as pursued above with *Diabrotica*.

Regarding the sense of smell in the *Mollusca*, the testimony of many observers as recorded in the literature, so far as it goes, indicates that this sense is highly developed in the *Gasteropoda*, in both marine and land species. The well-known slug *Limax maximus*, a European form common in many localities on the Atlantic and Pacific coasts of the United States, is the only species that has particularly attracted my attention, though other related European species occur here and there in California. While none of our native slugs or snails, so far as I am aware, are regarded as pests these exotic slugs and the common *Helix aspersa* are under the ban as undesirable residents because of their destructive habits. They multiply rapidly, a small colony soon becoming a numerous community. Wherever they occur in considerable numbers it is hardly worth while to attempt making a lawn. The favorite mixture for seeding lawns in Los Angeles and elsewhere in the general region thereabout, is Kentucky Bluegrass, *Poa pratensis*, and the White Clover, *Trifolium repens*. With the earliest tinge of green upon the ground the slugs and snails make short work of the tender growth.

The *Limax** (*L. maximus*) is usually found in the rear of the house or back yard in crevices about the brick foundation, presumably attracted by the cooking odors of the kitchen. It is nocturnal in its habits. It makes its home under boards or piles of old bricks, in nooks and corners, preferring such places as are dark, damp and cool. At night it goes forth seeking what it may devour, and apparently always has a good appetite, and knows no such word as fail. In its foraging expeditions it makes a direct line, a short cut to the garbage can, if there is one, or whatever contains the refuse of the scullery; a greasy soup bone, even, does not escape attention. However distant these may be, or however dark the night, the sense of smell is the compass that guides, and it never loses the trail when on the home tack, returning to its hiding place about or soon after sunrise. Their slimy tracks when dry glisten like silver, and may be seen radiating like the spokes of a wheel where the hub or centre has been an old bone or piece of stale meat. Occasionally the slugs invade the kitchen and not infrequently their nightly excursions extend to the pantry.

Though a night traveler its eyes are apparently of little use, the exceeding development of the sense of smell compensating for lack or dimness of vision. With this in mind *Limax* can be diverted from its haunts when these are too near the house by keeping the garbage receptacle as far as possible away from the kitchen, and by furnishing cover near by in the shape of pieces of board, a pile of brick-bats or cobblestones in some dark, damp corner cool spot, and further by baiting with a greasy bone or stale fish, for the *Limax* is a scavenger and to a limited extent beneficial when seen in that light.

A slug-hunt should be in order once in a while, the oftener the better. The captives are easily killed by dropping them into any vessel containing strong brine. With these simple precautions they can soon be nearly if not quite cleaned out. When the kitchen or pantry is frequented fine salt liberally strewed on the floor near the threshholds may be used to advantage.

As to the seat of the sense of smell in the Insects and Mollusks, which has been discussed for many years, there is still a wide diversity of opinion. However, that is another story and need not be considered here.

* Nautilus, Vol. XVIII, Phila., July, 1904.